REMARKS

Claims 1-28 were previously pending in the application. Claims 5-6, 9, 16-18 21 and 24 have been cancelled and incorporated into the independent claims. New Claims 29-32 have been added. Claims 1-4, 7-8, 10-15, 19-20, 22-23, and 25-32 are currently pending. No claims are allowed.

Independent Claims 1, 2, 12, 13, 22 and 23 have been amended to incorporate limitations from cancelled Claims 5, 6, 9, 16, 17, 18 and 24 relating to the "fuming inorganic oxy acid". Newly added dependent claims 29-32 have been added wherein the graphite is expanded "at a power of at least 1040 Watts". Support for 1040 Watts (at 3 minutes) is found in Figure 4, as seen at the top of the figure. No significant remaining order is seen with treatment for 3 minutes at this power as illustrated by the x-ray diffraction pattern of Figure 4. The independent claims have therefore been amended to call for a treatment of "5 minutes or less", as described in paragraph [0062] on page 12 and Example 1, paragraph [0067] on page 14 of the application, "at a power so as to have no significant remaining order between the

platelets as seen by an x-ray diffraction pattern" described in paragraph [0034] on page 8, and paragraph [0059] on page 12 of the specification. Claims 2 and 13 have been additionally amended to call for an oxidizing agent as particularly disclosed on pages 13 and 14, paragraph [0068] of the application.

Independent Claims 1, 2, 12, 13, 21 and 22 have also been amended to specify the preferred pulverized platelets most of which are less than 1 μm as shown in Figure 6 and as described in paragraph [0070] on page 15 of the application. As specified in Claims 2 and 13, the platelets are preferably about 30 nm or less in thickness as described in paragraph [0079] as set forth on page 19 of the application. These platelets used in the composite material are the result of the specific treatment in the applicator and the specific pulverization of the treated platelets as set forth in the claims. Thus, the claims have been amended to clearly define the invention in relation to the time of treatment and the result. This was suggested as necessary in the Office Action.

Double Patenting

1. Claims 1 to 28 were previously rejected based upon double patenting. Applicants will elect to issue a patent in this application if the claims are allowed and cancel the claims in the copending application.

Claim Rejections- 35 U.S.C. §103

1. Claims 1 to 28 were rejected again under 35 U.S.C. §103(a) as being unpatentable over Saito *et al.* (U.S. Patent No. 6,024,900) in view of Adams *et al.* (U.S. Patent No. 6,200,915) to Ottinger *et al.* (U.S. Patent Application Publication No. 2002/0114952) to Blain *et al.*, (U.S. Patent No. 6,413,601) and Cha *et al.* (U.S. Patent No. 5,164,054); Greinke *et al.* (U.S. Patent No. 6,555,271); Bonville (U.S. Patent No. 6,248,462); and von Bonin *et al.* (U.S. Patent No. 5,288,429).

Saito *et al.* teaches that production of expanded graphite from the raw material can be conducted by a known process. "For example, concentrated sulfuric acid is mixed with hydrogen peroxide to form peroxomonosulfuric acid; thereto is added raw material graphite with stirring to give rise to a reaction for

about 1 hour to 1 day; and the reacted graphite is heated at 500-1,000°C in an inert gas." (Saito *et al.*: Col. 2, lines 59-65). According to Saito *et al.*, "expanded graphite obtained by adding 15% ammonium hydrogenperoxodisulfate to a mixture of 320 parts by weight of 95 wt.% concentrated sulfuric acid and 4 parts by weight of 62% hydrogen peroxide, mixing them with cooling to 20°C or lower, adding natural graphite to the mixture to give rise to a reaction for 24 hours, and firing the reaction product up to 1,000°C in nitrogen gas." Thus, Saito *et al.* describes using a conventional heating process to expand the graphite. Saito *et al.* does not show or suggest that a microwave or radiofrequency wave process for 5 minutes or less at a power so as to have no significant remaining order between the platelets as seen by an x-ray diffraction pattern to produce expanded graphite having residual expander removed.

It is further stated by Saito *et al.* that:

> "When the average particle diameter of the expanded graphite used in the present invention is smaller than 5 μm, the penetration of the thermoplastic or thermosetting resin into the gap between expanded graphite particles in a following mixing step is difficult, resulting the carbon

> composite material of very low gas non-permeability. When the average particle diameter is larger than 12 μm, the filling of the gap between expanded graphite particles, with the thermoplastic or thermosetting resin is insufficient, resulting the carbon composite material of (1) very low gas non-permeability and (2) reduced packing density which invites insufficient electrical connection and consequent low electroconductivity."

(Saito *et al*.: col. 3, lines 20-32). Clearly, 80% of the ground graphite must have a size of 5 to 12μm which is higher than presently specified in the amended claims. Also, Applicants claimed composite materials in the dependent claims 3 and 14 are electrically conductive as set forth in the paragraph bridging pages 28 and 29 of the application which is contrary to the assertions of Saito *et al*. in spite of the small particle size.

Blain *et al* generally teaches at column 5, lines 1 to 7, that graphite flakes can be exfoliated by exposing them to an energy source, including microwave or radio frequency radiation. However, Blain *et al* does not discriminate between microwave radiation and other sources of energy, such as heat sources including particularly a flame or energy provided by infrared radiation. Von Bonin *et al* teaches that microwaves are one method of heating the expandable graphite, but does

not teach advantages of a microwave treatment over conventional heating and certainly does not suggest such treatment for 5 minutes or less at a power so as to have no significant remaining order between the platelets as seen by an x-ray diffraction pattern so as to expand the graphite and remove residual amounts of the expander chemical as claimed.

To reiterate the earlier discussion in part, according to MPEP 2113, the structure implied by the process steps should be considered when assessing the patentability of product-by-process claims over the prior art, especially where the product can only be defined by the process steps by which the product is made, or where the manufacturing process steps would be expected to impart distinctive structural characteristics to the final product. In *re Garnero*, 412 F.2d 276, 279, 162 USPQ 221, 223 (CCPA 1979) (holding "interbonded by interfusion" to limit structure of the claimed composite and noting that terms such as "welded," "intermixed," "ground in place," "press fitted," and "etched" are capable of construction as structural limitations). The graphite platelets in the claims of the present

application have been described by a product-by-process limitation. The precursor graphite has been expanded by heating in a microwave or radiofrequency wave applicator for 5 minutes or less at a power so as to have no significant remaining order between the platelets as seen by an x-ray diffraction pattern so as to expand the graphite and remove residual expander chemicals and then pulverized to produce the graphite platelets most of which are 1 μm of less. Therefore, the structure implied by the process steps should be considered when assessing the patentability of the claims over the prior art.

In the rejection, it is stated that "It is not seen that adding energy via microwave or radio frequency emr produces different platelets than those of the prior art." However, the Declaration Under 37 CFR 1.132 filed with the Submission Under 37 CFR 1.114(c) illustrates that graphite rigidly expanded by a microwave process at a power of at least 1040 Watts for 5 minutes or less as now claimed specifically in Claims 29-32, has less residual expander as compared to graphite expanded by a long term heat treatment. The graphite expanded by a microwave process at a power of at least 1040 Watts has a

higher degree of expansion and has a cleaner surface than graphite expanded by a heat treatment. As can be seen in Table 2.1 and Figure 2.11 on page 88 of the dissertation of Hiroyuki Fukushima, entitled "Exfoliated Process for Graphite Intercalation Compounds", microwave exfoliated graphite has approximately a ten fold higher surface area and aspect ratio than heat exfoliated graphite. In addition, since intercalate acid residue remaining on the graphite surfaces after treatment could cause problems, the cleanliness of the graphite surface is important. Section 2.3.3.2 on page 89 of the dissertation of Hiroyuki Fukushima shows that the microwave treatments at some power outputs, especially at a power of at least 1040 Watts, have an advantage over the conventional heating process in terms of complete expansion and removal of the residual intercalates. Thus, graphite expanded by a microwave process for 5 minutes or less at some power outputs has superior properties as compared to graphite expanded by conventional heating processes.

As can be seen in Figure 4 of the present application, and Figure 2.9 on page 86 of the dissertation of Hiroyuki Fukushima, when graphite is

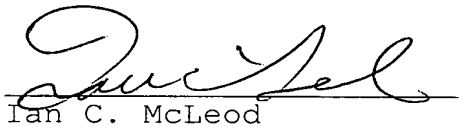
treated at a power of 1040 Watts for only three minutes no significant remaining order is seen as illustrated by the d002 plane of the x-ray diffraction (XRD) patterns. (Specification: paragraph [0034] on page 8, paragraph [0059] on page 12). Clearly higher powers outputs would result at least the same or better expansion of the graphite. When this is compared to Figure 2.8 on page 85, it is clear that the brief three minute microwave expansion results in superior expansion to that of heating at 900 °C for three minutes. This superior expansion is also illustrated by the d002 peak height illustrated in Figure 2.10 (A) and (B) on page 87 of the dissertation. The microwave expansion of graphite at at least 1040 Watts exceeds that of heat expansion even at the temperature of 1000 °C. The expanded graphite described by Saito *et al.* is obtained by firing *up to 1,000°C* in nitrogen gas. Therefore, it is clear that expansion at a power of at least 1040 Watts for less than 5 minutes produces a more fully expanded graphite.

These results are unexpected considering the teachings of the cited references. None of the cited references teach of the advantages of graphite expanded

by a microwave process for 5 minutes or less at a power so as to have no significant remaining order between the platelets as seen by an x-ray diffraction pattern and remove the expander chemical. None of the cited references teach expansion at a specific power of at least 1040 Watts as in dependent claims 29-32. Saito *et al.*, Adams *et al.*, Ottinger *et al.*, Blain *et al.*, Cha *et al.*, Greinke *et al.*, Bonville , and Von Bonin *et al.*, either taken alone or in combination, do not show or suggest the claimed invention. Reconsideration of the rejection is requested.

In light of the above, it is now believed that Claims 1-4, 7-8, 10-15, 19-20, 22-23, and 25-32 are patentable and in condition suitable for allowance. Applicants respectfully request that a Notice of Allowance be issued in this case.

Respectfully,



Ian C. McLeod
Registration No. 20,931

IAN C. McLEOD, P.C.
2190 Commons Parkway
Okemos, Michigan 48864

Telephone: (517) 347-4100
Facsimile: (517) 347-4103
Email: mcldmyn@comcast.net